NO. 22.

THE Sidereal Messenger.

Conducted by Wm. W. PAYNE,
Director of Carleton College Observatory.

MARCH 1884.

CONTENTS:

"To impress upon the mind the reality of the perfection of the works of the omnipotent, the living GOD."—Professor JAMES C. WATSON.

ARTICLES: PAGE.

The Determination of the division errors of a Meridian Circle by Dr. Keyser. Translated by Prof. E. S. Holden..... 33
Changes in the Brooks' Comet, (Illustrated)—W. T. Sampson..... 44
The Lunar Eclipse of Josephus Flavius, Prof John G. Hagen 48
Star-Studies with the Opera-Glass—The Editor..... 51
Pons-Brooks' Comet—E. E. Barnard..... 54
New Comet, Names of Minor Planets, and the Mean Solar Parallax..... 55

EDITORIAL NOTES:

Professor Holden's article—Note on the discussion of "The Deflection of the Level due to solar and lunar attractions" by Professor J. Hagen—Prof. C. S. Chandler calls attention to an outburst of light in the Brooks' comet, Sept. 22, '83—Prof. Davidson's notes on Saturn, Jupiter and Mars—Note on the 228th asteroid by Prof. Kirkwood—A new and remarkable nebula, (Illustrated) by Prof. Swift—The Warner Prizes for 1884—Interesting notes from Prof. C. P. Smyth, Astronomer Royal of Scotland—Mr. J. R. Hooper's observations on the comet—Mr. E. E. Barnard gives places of new nebulae—Proper motion of Lacaille 3643 by E. S. Holden—February subscriptions to the MESSENGER—Book notices—Observations of Pons' comet by W. T. Sampson—Wilson's notes and observations on the comet (Illustrated.) From pages..... 55 to 64.

ADVERTISEMENTS:—Cover pages.

THE MESSENGER will be published monthly, except for July and September. Subscription price per year (ten numbers), $2.00.
All communications should be addressed to the Editor,
Northfield, Minnesota.

NORTHFIELD, MINN.
CARLETON COLLEGE OBSERVATORY
1884.

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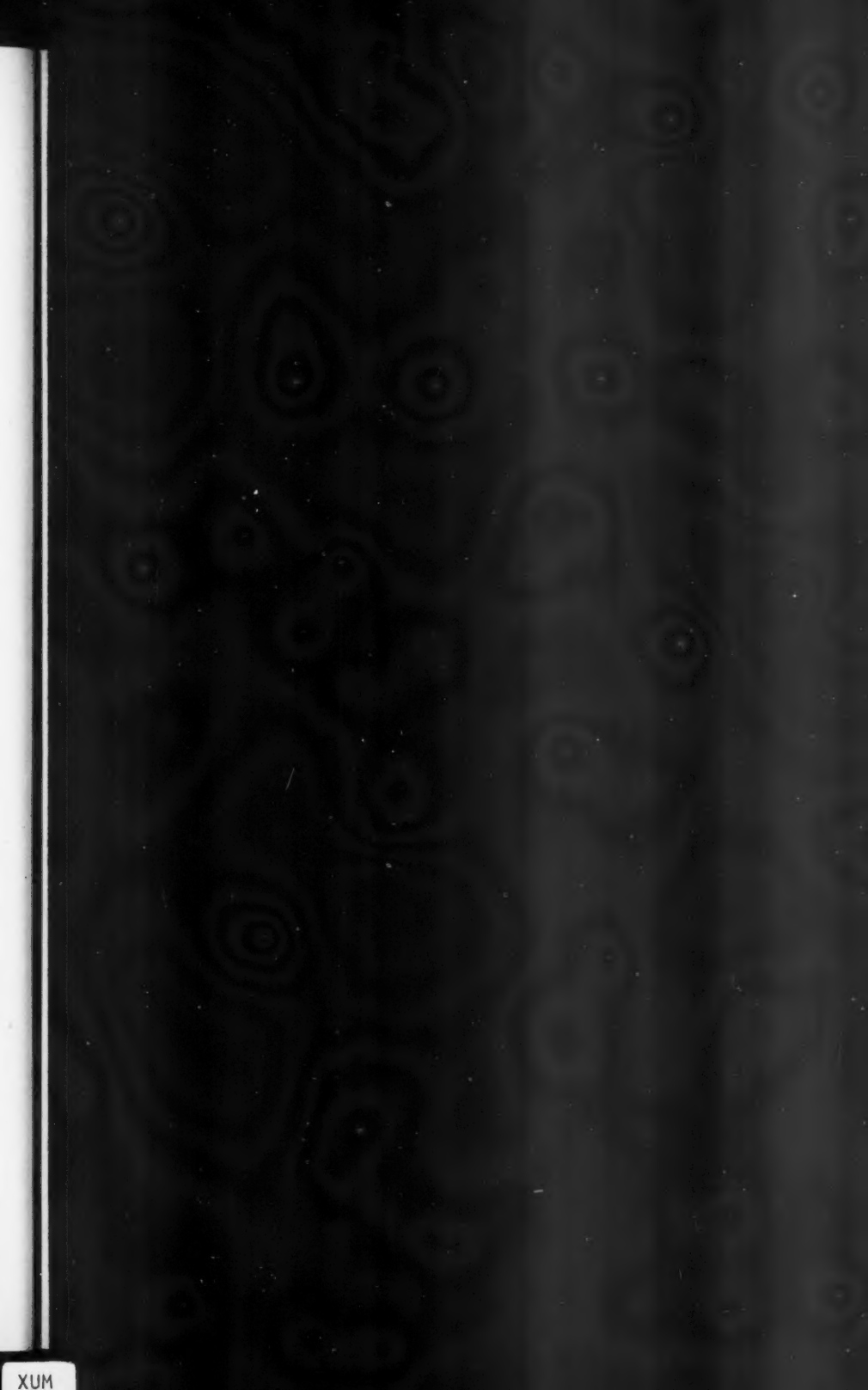
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The Sidereal Messenger.

Conducted by WM. W. PAYNE, Director of Carleton College Observatory.
Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. NO. 2. MARCH, 1884. WHOLE NO. 22.

The Determination of the Division Errors of a Meridian Circle, by DR. KEYSER, *Director of the Leyden Observatory. Translated and abridged from the Leyden Observations, Vol. II, by* EDWARD S. HOLDEN.

The ordinary method of determining the Division Errors of a Circle depends on the assumption that the small differences between arcs which should be equal, can be measured with precision by means of micrometer microscopes, and upon the axiom that the whole is equal to the sum of all its parts.

If we have an arc whose terminal lines are a and z and which is divided into k like parts by intermediate lines b, c, d, etc., to determine the errors of these intermediate lines we use two microscopes at a distance apart of nearly ab, bc, cd etc.

Turning the circle, we place the first microscope on a, and we read the second microscope on b by means of its micrometer-head. Then by turning the circle, the first microscope is pointed on b, and the second is read on c. This

process is continued until all the small arcs *ab*, *bc*, *cd* etc., have been compared with the first.

The differences $bc - ab = \mathrm{m}$,

$cd - ab = \mathrm{n}$,

$de - ab = \mathrm{o}$,

etc.,

are then formed; and $\mathrm{m} + \mathrm{n} + \mathrm{o} + \text{etc} = \mathrm{P}$. Suppose the errors of a and z to be $f(\mathrm{a})$ and $f(\mathrm{z})$ then we have,

Error of $a = f(\mathrm{a})$

$$b = f(\mathrm{a}) + \frac{f(\mathrm{z}) - f(\mathrm{a})}{\mathrm{k}} + \frac{\mathrm{P}}{\mathrm{k}}$$

$$c = f(\mathrm{a}) + \frac{2[f(\mathrm{z}) - f(\mathrm{a})]}{\mathrm{k}} + \frac{2\,\mathrm{P}}{\mathrm{k}} - \mathrm{m}$$

$$d = f(\mathrm{a}) + \frac{3[f(\mathrm{z}) - f(\mathrm{a})]}{\mathrm{k}} + \frac{3\,\mathrm{P}}{\mathrm{k}} - \mathrm{m} - \mathrm{n}$$

etc., etc., etc.

The *eccentricity* must also be eliminated, and this is done in the simplest manner by reading two microscopes, 180° from each other and taking the mean of their readings.

Thus we add to the first and second microscopes, two others diametrally opposite, and by reading all four microscopes for each setting we compare those arcs which are limited by the lines, $180° + a$, $180° + b$, $180° + c$, etc. as well as those first named. If the means of the readings of opposite microscopes are formed, the computation gives the half-sum of the errors of two opposite lines, that is to say the error of that diameter which passes through these lines; and this quantity is all that it is necessary to know.

In the determination of the division errors of the Leyden circle, no cases have arisen which are not comprised in the division of an arc of the circle, or the angle between two diameters into *two* or *three* equal parts. The process is extremely simple, but as it is easy to err in prefixing the + or − sign to the quantities determined, I will write out the programme which I prepared, in full.

If we always give to an error a sign such that if we apply the error with the sign to the erroneous reading we shall

obtain the correct reading, it is to be remarked that the *error of an arc* has a different sign from the *error of its terminal line*, whose erroneous position is the cause of the error of the arc.

If for example the lines 0° and 90° are exactly right, and the arc 0°—45° too large, the *error of this arc is negative.* The *line* 45° must then lie further from 0° than the true position of 45°, and when 45° is read on the microscope, the screw must be turned farther [since the microscope revolutions increase from 45° towards 0°] and therefore the *error of the line is positive.*

In ordinary observations, we have to determine that point of the divided limb which lies between the two threads of the microscope, when its scale and head stand at 0_{rev} and zero. By means of the screw we measure the distance between this zero and the next *less* division, and the required quantity is the sum of this next less division and the microscope reading on it.

The numeration of the seconds on the microscope-micrometer-head increases as the numeration of the circle decreases. If we have read two microscopes, the difference of these readings is the distance of the zeros of these two microscopes relatively to the lines employed.

In the investigation of division errors however, we have to determine the distance between two lines referred to the distance between the zeros of two microscopes. If the difference between the readings of two microscopes is too *large*, the arc in question is too *small.* This assumes that the microscopes are arranged as for ordinary observations.

The investigation of division errors depends entirely upon the determination of the small differences between arcs which should be alike. Within certain limits, the distance of the two microscopes is arbitrary provided it remains constant.

We may if we like, reverse the micrometer-box of one of the microscopes or set the circle by a contrary way, and the whole problem comes back to this: to decide which one of two arcs compared with each other, is the larger. All dan-

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ger of mistake is avoided, if we remember that, in the ordinary arrangement of microscopes a larger difference between the readings of the micrometer-heads corresponds to a smaller arc of the division of the circle.

I assume that the arc $a\,c$ on the limb of the circle should be divided into two equal parts by the line b, and that the lines $a\ b\ c$ follow each other in the same order as the increasing numbers on the circle. That is c corresponds to a larger number than b, and b than a.

Let two microscopes I and II be so placed that II always corresponds to the greatest degree in the numeration of the circle, and that their distance is ab or bc approximately. Now bring ab under the microscopes and read the micrometer-heads of both I and II. Then bring bc under, and again read both I and II.

When ab is under I and II let

m be the reading of the head of I on a,
n " " " " " " " II " b.

When bc is under I and II let

o be the reading of the head of I on b,
p " " " " " " " II " c.

Call the errors of a and c, $f(\mathrm{a})$ and $f(\mathrm{c})$.

Then

$$\text{Error of } b = \frac{(\mathrm{p}-\mathrm{o})-(\mathrm{n}-\mathrm{m})}{2} + \frac{f(\mathrm{a})+f(\mathrm{c})}{2}$$

If we have an arc ad which should be divided into three equal parts by b and c, I and II are to be set at the distance ab, bc, cd and these arcs are to be compared.

a, b, c, d follow in order with increasing numeration of the divided circle.

When ab is under I and II;

m is the reading of I on a,
n " " " " II " b.

When bc is under I and II;

o is the reading of I on b,
p " " " " II " c.

When cd is under I and II;

q is the reading of I on c,
r " " " " II " d.

Call $f(a)$ and $f(d)$ the errors of a and d.

Then,

$$\text{Error of } b = +\tfrac{1}{3}[(r-q)-(p-o)]+\tfrac{2}{3}[(p-o)-(n-m)] + f(a)+\tfrac{1}{3}[f(d)-f(a)].$$

$$\text{Error of } c = +\tfrac{2}{3}[(r-q)-(p-o)]+\tfrac{1}{3}[(p-o)-(n-m)] + f(a)+\tfrac{2}{3}[f(d)-f(a)].$$

If, as is commonly the case, the errors of diameters [and not of arcs] are to be determined, microscopes III (opposite to I) and IV (opposite to II) are to be fixed, and the mean of the readings of the heads of I and III takes the place of m, o, q, while the mean of the readings of II and IV takes the place of n, p, r, in the preceding formulæ.

The application of this theory is limited by the practical fact that the microscopes can not be placed at *every* distance apart. In the Leyden circle the microscopes can not be brought nearer to each other than about 40°, and no matter how the microscopes are arranged, two of them must always remain a certain number of degrees apart.

If however, the whole circumference has been once divided into a certain number of equal parts, and the errors of certain divisions determined, arcs become known, which can be taken as greater than 360°, and whose aliquot parts are greater than 40°. By the subdivision of these arcs the errors of other lines, as yet unknown, can be determined.

By this process it is not difficult to determine the errors of every 5°, even in the case where the microscopes can be brought no nearer than 40°.

When we come to this point all arcs which are multiples of 5° become known, and by taking these large enough, we can again determine the errors of the 1° divisions.

If we have to determine the errors of the lines which lie close to each other [5′ to 5′, 2′ to 2′ etc.] the influence of the accidental errors of observation increases rapidly as we divide an arc into a large number of equal parts. HANSEN (in *Ast. Nach.* No. 388) has given a formula for the determination of the relative accuracy with which the different lines are determined. The proof of this is not difficult and it results from what follows:—

Let

m be the number of small equal arcs into which a larger arc is to be divided,

w be the probable error of each one of these smaller arcs,

$w(r)$ be the probable error in the determination of the error of the rth line, then

$$w(r) = w\sqrt{\left\{\frac{r(m-r)}{m}\right\}}$$

The maximum value of $w(r)$ corresponds to $m = 2r$.

A single microscope commands a certain portion of the divided limb, and within its field the distances of the visible lines may be measured and compared.

If we assume that the division errors for every 5° are determined, and that the 5′ lines are to be fixed, it would be necessary to divide the 5° spaces into 60 equal parts, and the weights of the resulting division errors of the $2\frac{1}{2}$° marks would be one-fifteenth of the weight of the measure of a single space.

If the circle is divided to 2′, the 5° spaces must be divided into 150 equal parts and the weight of the $2\frac{1}{2}$° marks would be 37.5 times less than the weight of the measures of a single space.

* * * * * *

There are only four instruments known to me which have the errors of each 1° determined by direct measures. These are the Pulkova vertical-circles and the meridian-circles of Greenwich, Paris and Washington.

* * * * * *

I have found a very simple arrangement [for the determination of the errors of every line] which was first described in the Leyden Observations, Vol I, page LXXXIII.

Although it is not possible to properly place two microscopes within a very short distance of each other, there is nothing to prevent placing them so that their distance shall be 180° ± this small distance.

By turning the circle the lines a, b, c, to be investigated are brought in succession under microscope I, and microscope II is read in succession on the lines under it. The circle is then turned about 180° and the lines which

lay 180° from *a*, *b*, *c* in the first process, are now brought under I, and microscope II is read on the marks under it.

A very simple combination of the differences of the readings of Mic. II, gives the half sum of the errors of the lines which lie 180° from each other and thus the error of the diameter with which we alone have to do.

This method has many advantages, chief among which is that two auxiliary microscopes can be placed so as not to interfere with the four used for regular observations. * * * In order to avoid the awkward expression, *Correction on account of an error of division*, I shall, in what follows, denote by the *division-error* of a line, that quantity which must be applied to the reading on that line, with its proper sign in order to obtain the correct reading. [In other words division-*error* here means division-*correction*.]

The *division-errors* of the lines *a*, *b*, *c*. etc., I denote by $f(a), f(b), f(c)$, etc.

That terminal line of an arc which corresponds to the *smaller* reading of the circle numeration, I call the *under*, that which corresponds to the greater reading of the circle I call the *upper* terminal line, so that the direction from the *under* to the *upper* terminal line is the direction of increasing graduation.

If the *under* line is correct, but the arc too large the *upper* line falls on a part of the limb where the microscope must read more than the line gives. The division-error of the line, is in this case positive, whereas the error of the arc is negative. In general, if a line lies at a point of the limb where the arc is greater than the name of this line, then we must read at the line *too little* and its error is positive.

Let *a* be the *under*, *b* the *upper* end-lines of an arc *ab*, and let the (positive) errors of *a* and *b* be $f(a)$ and $f(b)$. Let A and B be the points of the limb where *a* and *b* should fall, then *a* lies in relation to A, and *b* to B in the direction of increasing graduations. *a* lies between A and B, B lies between *a* and *b*, and the arc A B is the value which *a b* should have. Thus

$$ab = AB - Aa + Bb$$
$$ab = AB - f(a) + f(b).$$

If you look at either of the Leyden circles from the side on which it is divided, the graduations increase in the order left hand, top, right hand. On the left hand, at the end of a horizontal diameter I put a microscope without a micrometer, which I call microscope I. Opposite it, is a micrometer-microscope, II. The divided head of II is directed upwards. If this head is turned in the direction of increasing readings the threads move in the direction of increasing circle graduations.

Increasing numbers on the divided head thus give greater arcs on the limb of the circle. This is the opposite of the ordinary arrangement.

Let a be the under, z the upper terminal-line of an arc az which is divided by the lines b, c, d, etc. into parts which should be equal. a b c – – – follow in the order of increasing graduation. Let a′ b′ c′ – – – z′ be the divisions lying opposite (diametral) to a b c – – – z.

Assume that the errors of the diameters aa' and zz' are known: that is $\frac{1}{2}[f(a) + f(a')]$ and $\frac{1}{2}[f(z') + f(z')]$ are known.

The errors of the diameters bb′, cc′ etc. are to be determined: that is $\frac{1}{2}[f(b)f(b')]$; $+\frac{1}{2}[f(c)+f(c')]$ are to be determined.

Microscopes I and II were first so placed that their distance, counted from I in the direction of increasing circle graduations was very nearly $180° + ab$.

By turning the circle a, b, c, – – – are brought successively under I. b′, c′, d′ come under II, which is pointed on each one and read for each. The difference between two immediately following readings of the head gives one of the differences

$$ab - b'c'.$$
$$bc - c'd',$$
$$cd - d'e',$$
etc. etc.

As the reading of the head of II. increases with increased readings of the circle, $b'c'$ will be smaller than the arc ab,

when the reading of the head for the pointing on b and c' is smaller than for the pointing on a and b'.

In this case the difference:

$$ab - b'\,c'$$

is positive; and so for $bc - c'\,d'$ etc.

If we write all degrees and minutes on which the lines a, b, c, etc., fall, in order in one column, and if in a parallel column we write the readings of the head of II which correspond to them, we have only to subtract each number of this second column from the one standing immediately over it, in order to obtain the quantities.

$$ab - b'\,c'$$
$$bc - c'\,d'$$
$$cd - d'\,e'$$
$$\text{etc.}$$

with their correct signs.

After a b c d - - have been set, in their order under I, and the corresponding readings on b′ c′ d′ made by II, the circle is to be turned 180°.

a′ b′ c′ - - - are then to be placed, in order, under I, and II is to be read on the lines b, c, etc.

If a′ b′ = bc, then the reading of II for b and c would be the same.

If the reading for c is less than the reading for b then bc is less than a′ b′ and

$$a'\,b' - bc \text{ is positive and not}$$
$$b\ c\ - a'\,b'$$

If as before the circle divisions corresponding to a′ b′ c′ - - - are placed under each other and in a 2d column the corresponding readings of II on b c etc., and then each number in this 2d column subtracted from the one immediately over it, then we shall have the quantities.

$$a'\,b' - bc,$$
$$b'\,c' - cd,$$
$$c'\,d' - de,$$
$$\text{etc.}$$

with their proper signs.

For brevity let us put

$p = ab - b'c'$, $\quad q = a'b' - bc$,

$r = bc - c'd'$, $\quad s = b'c' - cd$,

$t = cd - d'e'$, $\quad u = c'd' - de$,

$v = de - e'f$. $\quad w = d'e - ef$.

etc. $\qquad$ etc.

$$k = \tfrac{1}{2}[f(a) + f(a')]; l = \tfrac{1}{2}[f(z) + f(z')].$$

So that k and l are the errors of the diameters of the terminal lines of the arc which is to be divided.

k always refers to the *under*, l to the *upper* terminal line.

Also, let $f'(b,) f'(c)$ etc., be the errors of the diameters corresponding to b, c, etc., so that

$$f'(b) = \tfrac{1}{2}[f(b) + f(b')]; f'(c) = \tfrac{1}{2}[f(c) + f(c')]$$

and let m be the magnitude which each of the arcs ab etc. must have

* * * * * * * * * *

Division of an arc into two equal portions.

An arc ac has the errors of the end lines $f(a)$ and $f(c)$ given. The error of the middle line b is required.

$$p = ab - b'c',$$
$$ab = m - f(a) + f(b)$$
$$b'c' = m - f(b') + f(c')$$
$$p = f(b) + f(b') - f(a) - f(c')$$
$$= 2f'(b) - f(a) - f(c')$$

$$q = a'b' - bc,$$
$$a'b' = m - f(a') + f(b')$$
$$bc = m - f(b) + f(c)$$
$$q = f(b) + f(b') - f(a') - f(c)$$
$$= 2f'(b) - f(a') - f(c)$$

$$p + q = 4f'(b) - 2f(a) - 2f(c)$$
$$= 4f'(b) - 2f(k+l)$$

$$f(b) = \frac{p+q}{4} + \frac{k+l}{2}$$

Division of an arc into three equal parts.

An arc ad has the errors of its end-lines $f'(a)$ and $f'(d)$

known. The errors of the middle lines b, and c, are required.

* * * * * * *

$$f[b]=\frac{p+q}{3}+\frac{r+s}{6}+\frac{k+l}{3}+\frac{k}{z}$$

$$f[c]=\frac{p+q}{6}+\frac{r+s}{3}+\frac{k+l}{3}+\frac{l}{3}$$

Division of an arc into five equal parts.

An arc *af* has the errors of its terminal lines $f[a]$ and $f[f]$ known. Required the errors of the intermediate lines b, c, d, e.

Put $$\alpha=\frac{4[p+q]}{10}+\frac{3[r+s]}{10}+\frac{2[t+u]}{10}+\frac{v+w}{10}$$

$$\beta=\alpha-\frac{p+q}{2},$$

$$\gamma=\beta-\frac{r+s}{2},$$

$$\delta=\gamma-\frac{t+u}{2}.$$

Then,

$$f[b]=k+\tfrac{1}{5}[l-k]+\alpha$$
$$f[c]=k+\tfrac{2}{5}[l-k]+\alpha+\beta$$
$$f[d]=k+\tfrac{3}{5}[l-k]+\alpha+\beta+\gamma$$
$$f[e]=k+\tfrac{4}{5}[l-k]+\alpha+\beta+\gamma+\delta$$

The terms of the above formulæ which do not contain k and l give the errors of the intermediate lines, in relation to the end lines. I call them *relative-errors*, and they would be absolute if the end-lines were correct. The terms containing k and l, give that part of the error of the intermediate lines which depends on the errors of the end-lines. The sum of these two parts I call the *absolute error* and this it is which must be applied to the reading on any line to free that reading from division error.

These two parts of the absolute error are presented [in tables which are omitted here] separately, so that a new determination of the parts containing k and l may be at once introduced into the determination of new absolute errors.

For a circle divided to 5′, for which the errors of each 5° are

already known, two observers working together for one hour daily require about three months to determine the errors of each line. This is $\frac{4248}{4320}$ of the whole number of the lines.

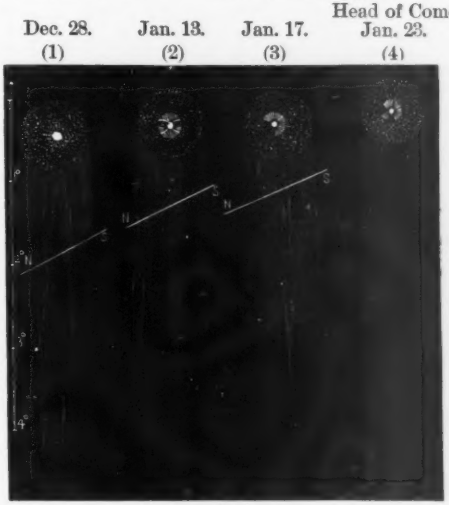
[A circle divided to 2′, whose 5° spaces were known would have 10,728 lines to be determined, and some 2.5 times three months would be required for the observations; say seven and a half months, an hour each day for two observers.]

CHANGES IN THE BROOKS' COMET.

W. T. SAMPSON, NAVAL OBSERVATORY, WASHINGTON, D. C.

I send you a sketch of BROOKS' comet in which an attempt is made to represent a remarkable change which took place in the comet about January 13. On that evening the comet presented, in the 9.6-inch equatorial, the appearance shown in fig. (2). The well-defined and almost circular envelope which is represented was entirely wanting when the comet was seen on previous occasions. The nucleus was much more condensed and star-like than at any time before. The envelope was of nearly uniform brightness, radial in structure, with a perfectly defined outline which was easily measured. It seemed to be produced by two fan or sector shaped emanations from the nucleus which curving backward toward each other, met at the outer edges, leaving a darker elliptical space on each side of the nucleus. The space on the north side being the darker, and the preceding fan-shaped portion having an extension on the north side. A line drawn through the middle of the dark spaces would be perpendicular to the axis of the tail. The diameter of this envelope was 1′ 20″, while the diameter of the outer nebulous envelope, as far as it could be readily traced, was about 6′ 9″. The spectroscope showed a bright continuous spectrum which was surprisingly strong in the red which completely masked many lines. As the comet had not been seen here for several days, this condition of things may

have been of considerable duration. Clouds prevented another view until January 17, when the head presented the appearance represented in fig. (3). The inner envelope had lost its sharp outline, and the following portion had disappeared, leaving a corresponding dark space; while the preceding portion had increased its angular dimensions and revolved through an angle of about 60°. This is the appearance it presented, though the change may have occurred in a very different manner. The 26-inch equatorial did not



BROOKS' COMET.

bring out any additional details. The distance from the following side of the nucleus to the outer edge of the inner envelope was about 32″; whereas it had been 40″ on the 13th, taking half the diameter of the envelope on the 13th to represent the corresponding measurement on the 17th. This peculiar bright envelope seemed entirely to disappear for a number of days, leaving the nucleus surrounded by the ordinary coma having no structural appearance. Again, on January 23rd it was developed into the form shown in fig. (4); the terminating line passing tangent

to the nucleus being curved backwards as on previous occasions, leaving a large sector much less strongly illuminated on the north side. On the south following side there was a dark rift or sector as shown in the figure. On this occasion the diameter of the bright envelope was only 32″.7, being much smaller than on the previous occasions.

A very marked increase in the length of the tail of the comet occurred between Dec. 27th and Dec. 28th. Fig. (1) gives an idea of its appearance on the last mentioned day. For about one-third of its length, the tail was broad and fairly uniform in brightness; from the middle of this broad portion issued two long bright streamers, one being longer and brighter than the other. The total length was about four degrees.

The Lunar Eclipse of Josephus Flavius, a Problem for College Students. *Professor* JOHN G. HAGEN, S. J., *College of the Sacred Heart, Prairie Du Chien, Wisconsin.*

I. It is well known that the Jewish historian, Josephus Flavius, in his *Antiquitates Judaicæ* (XVII c. 6. n. 4), mentions a lunar eclipse, that was visible in Jerusalem the night after the cruel execution of forty students and their teachers, Judas Sariphai and Mathias Margalothi, by King Herod. As this tyrant died only a few months later, this eclipse has become an object of interest both to historians and astronomers.

In a recent publication,* Florian Riess, S. J. has shown that the eclipse must have taken place within the years 750 and 753 a. u. c., and that, as Herod died shortly before Easter, only the following probable eclipses are to be computed:

750 a. u. c. March 12-13,
751 " Jan. 31 and Marh 1-2,
752 " Jan. 20,
753 " Jan. 9-10.

*Das Geburtsjahr Christi, Stimmen aus Maria Laach, 1880.

The first of these was indeed visible in Jerusalem, having its middle after 2 o'clock in the morning, and being nearly six digits in magnitude. It was first computed by Keppler†, and considered by him as the one recorded by Josephus.

In the second case, the full *Moon* was not near enough the nodes to be eclipsed by the *Earth's* shadow; and in the third, the eclipse was not visible in Jerusalem; for it was entirely over, when the *Moon*, about 6 o'clock in the morning, rose above the eastern horizon.

In the last case, Jan. 9-10, 753 a. u. c., the eclipse was total and almost central, and visible in Jerusalem during its whole course.

Florian Riess, S. J. alleges that two grave reasons against Keppler, in favor of this latter eclipse as the historical one. In the first place, he says, Keppler's eclipse was far less calculated to leave on the minds of the people such an impress of Heaven's anger against Herod's cruelty, as to be remembered at the historian's time, ninety years after. Secondly, Josephus Flavius mentions a great many facts, as Herod's sickness, his journey to Kallirhoe, his death and funeral, etc., as happening between the eclipse and the Paschal feast, which can not possibly be piled up between March 13 and Easter; no such difficulty, however, can be urged against the last eclipse.

On the strength of these premises, therefore, the above-mentioned author computed the elements of this eclipse from the tables of Delhambre, Olufsen and Hansen, as follows:

Jerusalem mean time of opposition (in longitude) 753 a.u c. Jan. 9, $13^h\ 16^m\ 29^s$.

Sun's longitude	287°	35′	52.″6	Hourly motion		2′	32″.9
Moon's longitude	107	35	52. 6	Hourly motion		36	51 .4
Moon's latitude			—73. 8	Hourly motion	−	3	13 .1
Sun's equa. hor. parallax	π=		8. 7	True semi-dia.	R=16	15	.0
Moon's equa. hor. parallax	p=1	0	17. 0	True semi-dia.	r =16	27	.2

II. The writer wishes to avail himself of this opportunity

†Invenitur autem eclipsis lunæ partialis digitorum pene sex, mane, diei 13, martii anno 42 (= 750 a. u. c), tribus horis ante solis ortum.

to show how this, and similar problems, may be given to students even in the lowest algebra classes as soon as they have become acquainted with equations of the second degree, and with the theorem of Pythagoras, viz: That in a right-angled triangle the square of the hypothenuse equals the sum of the squares of the other two sides. The solution of the problem comprises three parts, viz: The times of the contacts, the magnitude of the eclipse, and the angles of egress and ingress.

1. *Times of contact:*

If ρ denotes the radius of the earth's shadow, *i. e.* the radius of the circle in which the cone of shadow is intersected by a plane perpendicular to its axis and passing through the center of our satellite, a simple geometrical consideration furnishes the following value for ρ.

$$\rho = \pi + p \pm R \begin{cases} + \text{ for penumbra} \\ - \text{ for umbra,} \end{cases}$$

which is to be increased by 2 per cent. on account of the terrestrial atmosphere. By the theorem of Pythagoras the equation for outer and inner contacts will be

$$(\rho \pm)r^2 = a^2 + b^2$$

where a and b denote the distances of the two centers in longitude and latitude. The number of hours elapsing between opposition and contact, may be denoted by x, and this, multiplied by the hourly motion, will give the increment (positive or negative) of a and b from the time of opposition to the moment of contact. Thus, in the case of the present problem the equation of outer and inner contacts is:

For the *Umbra:*

$$(2703.7 \pm 987.2)^2 = (73.8 + 198.1x)^2 + (2058.5x)^2$$

$$x = -.0034 \pm \sqrt{\begin{matrix} 3.184109 + .0034^2 & \text{outer contacts} \\ 0.687643 + .0034^2 & \text{inner contacts;} \end{matrix}}$$

and for the *Penumbra:*

$$(4692.8 \pm 987.2)^2 = (73.8 + 198.1x)^2 + (2058.5x)^2$$

$$x = -.0034 \pm \sqrt{\begin{matrix} 7.542337 + .0034^2 & \text{outer contacts} \\ 3.209307 + .0034^2 & \text{inner contacts.} \end{matrix}}$$

The number before the root denotes the *middle* of the eclipse, viz. 0.0034 hours or 0.2 minutes before opposition whilst the root itself expresses *half the duration* between

first and second contact. Thus we obtain the following phases in mean time of Jerusalem:

First contact with penumbra, 753, Jan. 9^d	10^h	31.^{m}5
Second contact with penumbra,	11	28.8
Moon enters shadow,	11	29.2
Total eclipse begins,	12	26.5
Middle of the eclipse,	13	16.3
Total eclipse ends,	14	6.1
Moon leaves shadow,	15	3.4
Third contact with penumbra,	15	3.8
Fourth contact with penumbra,	16	1.1

2. Magnitude.

The *magnitude* of an eclipse, or the part of the diameter obscured, equals the sum of the radii of the two disks in question, minus their least central distance. If the magnitude is to be expressed in decimals of the diameter, the angular magnitude is to be divided by this diameter; and if in digits, this last result is multiplied by twelve. In the present case we have, by the theorem of Pythagoras, for the least central distance d of the disks (shadow and moon) the formula:

$$d^2 = (\rho+r)^2-3.184121\,(198.1^2 + 2058.5^2).$$

These figures have been explained and already computed in the equation of contacts, so that by a simple substitution we find $d = 73.''67$. The eclipse was therefore almost *central*. Then the magnitude is:

$$\frac{\rho=r-d}{2r}=1.832, \text{ (moon's diameter}=1).$$

3. Angles of Ingress and Egress.

Even this part of the problem may be solved by such students as are not yet acquainted with trigonometry, provided the professor shows them a table of natural sines or cosines, and explains the definitions of these functions. The sines (cosines) of these angles of contact are the quotients of the central distances in longitude (latitude) by the sum of the radii. If the angles of ingress and egress,

with reference to the umbra, are α and β respectively, we have in our present case

$$\sin \alpha = \frac{2058.5 \times 1.7878}{\rho + r}; \alpha = 86^\circ \text{ toward the east,}$$

$$\sin \beta = \frac{2058.5 \times 1.7810}{\rho + r}; \beta = 83^\circ \text{ toward the west,}$$

counted from the north point of the moon's limb, as referred to the ecliptic.

III. In conclusion, the following additional remarks might contribute towards encouraging teachers in proposing problems of this kind to their classes.

First, if the elements of the eclipse are referred to the equator, the relative distance and hourly motion in Right Ascension of the two disks must be multiplied by the cosine of their mean declination. If the students are not able to do this, it may be done by the teacher in preparing the problem.

Secondly, in the case of a *solar* eclipse or the *transit* of a planet, if the teacher does not like to take upon himself the trouble of correcting, for the parallax of his place, the geocentric elements, which he will find in the Ephemeris, he may let the students compute the circumstances of the eclipse or transit as seen from the center of the *Earth*; and then by means of a terrestrial globe with horizon frame, find the countries in which the two outer contacts and the middle of the phenomenon are visible. The *Sun* would then be imagined right above the globe; but the globe must be rectified according to the declination of the *Sun* and the times of the phases: if, moreover, a horizontal disk of pasteboard, hanging down from the ceiling by a string, be swept over the globe just so far north or south as agrees with the declination of the moon or planet, the motion of the cone of penumbra may be brought before the eye of the student in the clearest manner. The diameter of this disk, expressed in diameters of the globe, is given in the American Ephemeris under the letter *l*.

That problems of this kind are taken up with great interest by students of algebra is sufficiently proved by the

authority of the late Professor HEIS, who ranked first among his colleagues in Germany, and whose name is well-known also to the astronomers of this country. Amongst his numerous algebraic problems,* we find the two eclipses recorded in the history of the Peloponnesian war by Thucydides, and also the one mentioned by Cicero, De Republica I, 16.

In suggesting such astronomical problems to professors of algebra the writer feels confident, from his own experience in the class-room, of their practical utility; for he has had his pupils compute all the lunar and solar eclipses, together with the transits of *Mercury* and *Venus* as they have successively occurred; he even publishes the solution of this problem from their very copy-books. The interest displayed by his scholars he deems an evidence of success.

STAR-STUDIES WITH THE OPERA GLASS.

BY THE EDITOR.

From the letters received in regard to home studies of the stars with the opera-glass, since the issue of the last MESSENGER, there seems to be more general interest in this elementary work than was anticipated. In view of what appears, steps have already been taken to secure the necessary aids suggested in the outline of the plan of work in our last article, such as star-maps, blanks for records and tracing or sketching, opera-glasses, etc. It will require considerable time to gather the desired information and to get ready for active and continuous work. Meanwhile for many who have an opera-glass, it will certainly be a profitable exercise to make as complete a study of the instrument in hand as possible. Elemental works on physics will give the student a general idea of the form and arrangement of the lenses, how they bend the rays of light

* Heis' Collection has lately been translated into English, and, it is hoped, will appear before the public in the course of this year.

from a straight path and form images near the observers eye in a way more convenient for study. For a fuller knowledge of the physical properties of lenses in most common use, the more complete works by Ganot or Daschenel (though they are called elementary) will be found definite, helpful and satisfactory. If any such work is read with an instrument in hand, and an attempt is made to apply the principles faithfully and rigorously, most students will find the field of study just as large and interesting as they care to make it.

It must be sufficient now to say that the opera-glass, single or binocular, is a Galilean telescope, or a pair of such instruments. Its object-glass is a double convex lens and its eye-piece is double concave in form.

In the best instruments both object-glass and eye-glass are acromatic being conbinations of three pieces of glass in each. The middle piece in each case is flint glass, and the other two are crown glass.

Different kinds of glass are used in the same lens, so as to transmit light through it and focus the same without showing the colors due to refraction and dispersion of light rays. The flint glass has greater dispersion power than the crown glass because it contains about 33 per cent. of the oxyde of lead, not a trace of which is found in the other. On account of this, and the difference in shape of the two pieces, refraction is secured and dispersion is neutralized, and objects are magnified without colors in the light by which they are viewed. Many other interesting facts will appear in connection with the study of the physical properties of ordinary optical instruments.

One of the first things that observers do in preparing for astronomical observation with a new instrument is to determine its magnifying power and its field of view, as it is called, which meanes the angular space on the sky that the glasses will bring before the eye at once, on account of their size and the curvature of their surfaces.

This knowledge is essential to good observation because without it much of the work attempted will be uncertain,

for it can neither be checked, nor compared satisfactorily with similar work done by others.

The following are some of the more simple methods in common use for approximate results:

To find the magnifying power of the opera or field glass lay off distinct parallel lines on a smooth surface, as that of a planed board, say six inches apart.

Set the board thirty feet or more away, perpendicular to the line of sight, and view the spaces using the glass with one eye and the other without it, being careful to note how many divisions or spaces the unaided eye will make equal in width to a single division or space shown by the glass. If the glass magnifies three times, one space in the glass will just equal three seen by the unaided eye.

A number of devices will readily suggest themselves for determinating close approximations if the power is also fractional.

The opera-glass now at hand tried in this way shows a power of 2.6 nearly.

If we have any means of knowing the focal lengths of the object-glass and the eye-piece of any instrument, its magnifying power is then found by dividing the focal length of the object-glass by the focal length of the ocular.

The extent of field of view is easily found by noting the time that it takes any star near the equator to pass by the field. This time converted into degrees will give the magnitude of the field. Two stars whose distance apart is known may also serve the same purpose.

Another simple method consists in viewing an object thirty or forty feet distant and measuring on the same, the diameter of the field of view. Divide half of this diameter by the distance from the eye, and the quotient will be the natural tangent of half the field of view. A table of natural tangents will give the angular value sought.

Only the simplest and easiest methods of work are here given so that any person wanting to test an instrument for himself may be encouraged to do so because the task is not a difficult one.

XUM

The attempts, however, should be repeated times enough to show the substantial agreement of several results. Tried by the last method, the opera-glass at hand shows a field of 12° 24′.

Any persons interested in easy observations of the stars with the opera-glass as herein described and also in an article in the preceding number of this publication are requested to correspond for further information if desired.

PONS-BROOKS' COMET.

E. E. BARNARD, NASHVILLE TENN.

On the nights of Jan. 20 and 21, I had some very interesting observations of the comet. Jan. 20, with the eye alone, the tail was faintly visible for a distance of 18°, streaming back parallel to the southern outlines of the Zodiacal Light; though the tail was not noticeable for more than 1½° to 2° from the head, there seemed to be a bright brush to that distance that could be followed distinctly. The telescopic view was very striking; the nucleus, round and star-like and very bright. A friend present remarked at once on the stellar appearance of the nucleus. A very faint envelope extended completely around the head which was bright and very even in its light—not softening toward the edges—like a uniform disc. There was considerable coma about the nucleus which seemed to extend beyond the head of the comet in front. The body for a distance of about one degree to the rear of the nucleus was pretty bright and of uniform light, and apparantly the terminus, but issuing out from this was the fainter part of the tail, along which numerous faint dark lines were occasionally visible; and though looked for no decided separation was seen. One degree back of the nucleus the confusion of the cometary light suggested some sort of disturbance.

Jan 21, the naked eye view was as the night previous, but the telescope revealed remarkable changes. The nucleus

which was so distinctly stellar on the 20th had melted away into a mass of dense haze, the star-like form having entirely vanished. The head was very bright and even in light. Though closely looked for, I could not make out the faint envelope surrounding the head at the former observation. At the point one degree behind the nucleus, there seemed to be greater confusion of the light. The body of the comet appeared rapidly to swell and contract with quick pulsations in the light. I cannot force myself to believe this a deception, for close to the comet was a small star which seemingly for a moment would be involved in the nebulous matter and the next instant entirely free of it. The seeing was good, so it could scarcely be attributed to poor definition. The most remarkable change had occurred in the tail which had split into three distinct branches, at a distance a little over one degree back from the nucleus, the spaces were perfectly free of cometary matter. The southern branch was the brightest, the northern very faint. The split that caused the northern separation began at a greater distance from the head than the other.

On this date the same *flattening* of the head was noticeable aad the coma extended in front of the head for some little space, almost obliterating the outline of the comet.

DISCOVERY OF A NEW COMET—Professor KRUEGER reports that a message has been received from Melbourne announcing the discovery of a small comet on 1884, Jan. 12, in R. A. $22^h\ 40^m$, and S. Dec. $40^\circ\ 8'$, moving quickly towards the southeast. "Unless there has been some error in the transmission from Australia, the comet at present does not seem likely to become visible here."

NAMES OF MINOR PLANETS.—Herr Palisa announces that three of the minor planets discovered by him have been named as follows:—No. 220, Stephania; No. 221, Eos; No. 222, Lucia.

The Mean Solar Parallax from the Belgian observations of the transit of *Venus* (1882) at Texas is $8''.907 \pm 0''.084$.—*Observatory.*

EDITORIAL NOTES.

Professor E.S.HOLDEN's translation,the leader in this issue, is a most valuable paper on an important theme for the professional astronomer. Though occupying more pages than have been given to any one theme previously, those observers, or students of theory, for whom it is written, will find it by no means too long for interest or profitable study.

A.N.No.2,568 Professor J.HAGEN, College of the Sacred Heart,Prairie Du Chien, Wis., discusses" The deflection of the level due to solar and lunar attractions." If we remember rightly no less than six different solutions have been given to the "Lunar Deflection of the Vertical," and strange to say the one given by DR. PETERS, the only exact one, has been disregarded by those who have written since his time. We will soon publish the historical part of the article.

Professor S. C. CHANDLER of Harvard College observatory, kindly calls attention to the fact, that the outburst in the light of the Brooks' comet, Sept. 22, 1883, must have occurred in the space of four or five hours, as is strongly probable from observations in the *Astronomische Nachrichten*, No. 2453, and in *Nature* of about the same date. It is therefore very important that all observations of the comet on that day, in this country, by any persons who were following it should be known, that a complete history of its wonderful changes may be written if possible. To this end the MESSENGER especially requests that all observers examine their note-books and communicate to it everything of interest seen on that day.

Prof. DAVIDSON has communicated to the California Academy of Sciences some notes upon the appearance of *Saturn*, *Jupiter* and *Mars*. With regard to *Saturn* he states that the preceding part of the ring clearly shows the unequal division of the outer ring; the Encke dark division being nearer the outer circumference, whereas on the following part of the ring the reverse appears clearly to be the case. Because of this he attributes to the shadow of the outer edge the ring B projecting beyond the Cassini dark division and making it apparently broader and the inner part of the A ring narrower. This might lead to measurements for determining the height of this rim above the plane of A. He has noted a movement of the fine belt line accross *Saturn* to the southward; and thinks he has detected a fine dark line in the darker shading beyond the bright equatorial belt. Other points of interest are referred to in the case of *Saturn*; and a series of drawings of *Jupiter* has been kept up as well as of *Mars*. He reports a series of positions for the Pons, 1812 comet,extending from December 12 to January 25.

NOTE ON THE 228TH ASTEROID.

Agatha, the 228th minor planet, was discovered by Palisa, at Vienna, on the 19th of August, 1882. In Dr. Tietjen's *Circular Zum Berliner Astronomischen Jahrbuch* for January 15, 1884, Dr. Kreutz gives the following elements:

Longitude of perihelion	328° 58′ 21″
Longitude of ascending node	313 19 45
Inclination	2 33 18
Eccentricity	0.2397
Mean distance	2.1968
Period	1189d.3

The mean distance, it will be seen, is less than that of any other asteroid with the exception of *Medusa*. The perihelion distance is 1.669—almost exactly equal to the aphelion distance of *Mars*. The longitudes of the perihelia now differ by only four degrees. This, however, will not always continue; and hence in the distant future *Mars* and *Agatha* may approach each other so closely as to render the perturbation of the latter by the former a question of great interest. The two planets, it will be observed, have nearly the same inclination, or, in other words, more nearly in the same plane.

D. K.

A NEW AND REMARKABLE NEBULA.

Some ten years ago, while searching for comets, I ran across an exceedingly large and fairly bright nebula near twelve *Monocerotis* which I of course supposed was a familiar object to every astronomer. Since then I have observed it on a great many occasions, being

A NEW NEBULA.

sometimes in doubt if it were not after all simply a glow from the well-known cluster H. 2, VII, or 1424 of general catalogue. Not until three years ago, did I ascertain that the object was not recorded in any published catalogue of nebulae. On a very fine night soon after my 16-inch refractor was mounted, and, before it was brought into adjustment, I turned the telescope on the nebula, and, to my

surprise found it a very remarkable object, so much so as to appear worthy of an illustration. The sketch is drawn from memory, but I consider it a good representation. I have not been able to get an observation of it since. The telescope not being in adjustment I could only estimate its position but it will not vary much from R. A. $6^h\ 22^m$ Decl. $5°10'$. It slightly recedes and is a little north of the above cluster. With my 4½-inch it appears to have no definite outline like the *Merope* nebula, but with the 16-inch it appeared quite sharply defined and in shape a perfect ellipse, having at each focus either a round and much brighter nebula, or, it has two centers of condensation, probably the latter. It appears to be a nebula of the dumb-bell type, and is very large, one of the largest visible from this latitude, and, well worthy of a critical examination by astronomers. It is now favorably situated for observation, and I hope some astronomer will have a clear sky and be able to get its exact position. It is unaccountable to me that so conspicuous a nebula should have so long been overlooked. About eighteen months ago Mr. BARNARD, now connected with the Vanderbilt observatory, Nashville, Tenn., in his sweeps for comets, picked it up and called my attention to it, thinking it might possibly be a comet. LEWIS SWIFT.

PRIZES FOR 1884.

H. H. Warner has issued the following which will be of interest to astronomers all over the country:—

It is a gratifying fact that more astronomical discoveries, and those of more importance, have been made by Americans during the past few years, than by all the rest of the world combined. That this has been due largely, to the impetus given by competition for the honors and prizes awarded to discoverers cannot be denied, and in order that this interest may be continued and sustained, I offer the following prizes for 1884:

Two hundred dollars for each and every discovery of a new comet made during the year, subject to the following conditions:

1. It must be discovered in the United States or Canada, either by the naked eye or telescope, and it must be unexpected.

2. The discoverer must telegraph immediately to Dr. LEWIS SWIFT, director of the Warner observatory, Rochester, N. Y., giving the exact time of discovery, the position and direction of motion, with sufficient exactness, if possible, to enable at least one other observer to find it.

3. This intelligence must not be communicated to any other party or parties, either by letter, telegraph or otherwise, until such time as a telegraphic acknowledgment has been received by the discoverer from Dr. SWIFT. Great care should be observed regarding this condition, as it is essential to the proper transmission of the discovery,

together with the name of the discoverer, to the various parts of the world, which will be immediately done by Dr. SWIFT.

Three disinterested astronomers will be selected to decide all disputed questions. H. H. WARNER.

ROCHESTER, N. Y., Feb. 8th., 1884.

We can not resist the temptation to copy some paragraphs from a recent private letter from Professor C. PIAZZI SMYTH, Royal observatory, Edinburgh, Scotland, in relation to current work and the ROWLAND gratings. He says: "I obtained, last summer, by kindness of Professor ROWLAND one of his unequalled works in the shape of a ruled surface 3.5×5.0 inches on a flat plate of metal 6.4×5.4×0.75 inches. Number of lines=14.438 to the inch." "I am having a large apparatus, with achromatic objectives four inches in diameter, and 72 inches solar focus, made by Messrs. T. COOKE & SONS of York for the holding and using of the above grating worthily, and I expect it will answer excellently and something more, for *some* subjects. Not however quite so for the one subject I am working at now which is vacuum tubes of my own contrivance, and wherewith some of the gases, I have found, with a large prismatic apparatus that there are not fewer than 7000 or 8000 lines in the spectrum. But to get a dispersion to separate them 14,438 lines to the inch are not enough; for even if they be used with the fourth or fifth order of spectrum, in the place of the first or second, the bright lines of successive orders get mixed up and inevitably confused."

Professor SMYTH will doubtless soon try some of the more finely ruled gratings from Professor ROWLAND'S machine. Those containing 28.876 lines to the inch are said work well in the extremeties of the spectrum, while those with 43,314 lines to the inch on plane surface give very brilliant results. With all these gratings the achromatic objectives must be used if high magnifying power is desired.

Mr. J. R. HOOPER of Baltimore followed the Pons-Brooks' comet closely during the latter part of the month of January noting some interesting physical changes. Jan. 23, $6^h\ 30^m$ 75th Meridian time, he saw the nucleus double. Jan. 21 there was no sign of such a phenomenon, nor did he see it double after the observation on the 23d. He several times saw parts of circles of light around the nucleus indicating activity. These observations correspond to those made at Washington near the same time and elsewhere reported in this issue. Mr. HOOPER'S note of the observation made at the above date is as follows:

"Nucleus of Pons' comet seen to be elongated at an angle of about 20° with the tail. On closer examination seen to be double. The points of light distinctly separated, the one toward the tail smaller

and brighter—appearance like a double-star seen slightly out of focus and through some haze. Watched at intervals for 30m and until too low for good definition."

In the October number of the MESSENGER, I gave the approximate places of several new nebulae. The following is a more accurate place of one of them:

R. A. 3h 8m 33s.
Decl. —26° 12½′

It is a faint nebula, not large, pretty even in its light; a faint star close *p*—slightly *s*—probably involved. Star is *s* and *f* the nebula by about 30′.

E. E. BARNARD.

I have found an unrecorded nebula in

R. A. 8h 14m 4s
Decl. —36° 45′ 50″

It is a very faint nebula of moderate size; quite uniform in light, a small star involved (north of middle) probably a nebulous star. A brighter star lies north and just free from the nebula.

E. E. BARNARD.

PROPER MOTION OF LACAILLE. 3643

This star which has been observed by STONE (4801), YARNALL (3814) and ARGELANDER (9264) has proper motions of about —0s.026 and + 0″.37 in R. A. and Dec. respectively.

EDWARD S .HOLDEN.

REPSOLD'S POSITION-MICROMETER.

It may interest some of your readers to know that the price of a REPSOLD micrometer like that described in the Encyclopædia Britannica, Vol. XVI—article micrometer—for a 15-inch telescope, is $1250.

EDWARD S. HOLDEN.

To be sure that the MESSENGER should not in the future be sent to subscribers not desiring its continuance, notice was recently sent to every one whose subscription to Vol. 3 was due suggesting that the publisher be informed of the wish of every such person. Many pleasant and encouraging replies have already been received. It is probably too much to expect that *none* would forgot to attend promptly to a matter even so important as this.

During the month of February subscriptions were recieved as follows:

C. A. Hubbard, Lake City, Minn.; Albion College Library, Albion, Mich.; Ladies' Hall reading room, Carleton College, Northfield, Minn.; A. E. Engstrom, County Supt. of schools, Cannon Falls, Minn.; Professor C. A. Young, Halsted observatory, Princeton, N. J.; Professor

Daniel Kirkwood, State university, Bloomington, Ind.; Judge N. H Hemiup, Minneapolis, Minn.; Professor W. Upton, Brown university Providence, R. I.; Rev. H. Robinson, Leadville, Colorado; Professor J. Hagen, S. J. Sacred Heart College, Prairie Du Chien, Wis.; Professor D. Green, Scientific school, Troy, N. Y.; Miss Grant, 249 Dearborn avenue, Chicago; Samuel A. Boyle, attorney at law, Philadelphia, Pa.; Professor N. O. Wardlaw, Christiansburg, Va.; J. M. Thompson, Salem, O.; C. L. Clippinger, M. E. College, Fort Wayne, Ind.; Dr. W. L. Nicholson, Fort Dodge, Ia.; Professor H. S. S. Smith, Princeton, N. J.; Reading room, Wellesley College, Wellesley, Mass.; Geo. B. Merriman, Rutger's College, New Brunswick, N. J.; Professor R. W. McFarland, State university, Columbus, O.; Professor C. A. Young, Halsted observatory, Princeton, N. J.; S. S. Cheevers, Rector Episcopal church, Shamokin, Pa.; Professor W. J. Warren, Minneapolis, Minn.; Professor D. B. Purinton, West Virginia university, Morgantown, West Va.; Charles P. Howard, Hartford, Conn.; Harvard College Library, Vol. I and II (bound,) Cambridge, Mass.; Geo. C. Hill, Rosemond, Ill., M. H. Cryder, Morris, Ill.; Dr. J. H. Cryder, Morris, Ill.; Dr. J. H. Wythe, Oakland, Cal.; Geo. W. Armes, San Francisco, Cal.; Charles Burckhalter, Oakland, Cal.; James Lick Trust, San Francisco, Cal.; Thomas Thomas, Trenton, N. J.; C. W. Irish, civil engineer, C. & N. W. railway company, Iowa City, Ia.; Professor C. Bates Johnson, Providence, R. I.; F. E. Seagrave, Seagrave observatory, Providence, R. I.; Library of Amherst college, Amherst, Mass.; W. H. Stevens, Carson, Nevada; Professor J. S. McGhee, State Normal school, Cape Girardeau, Mo.

BOOK NOTICES.

The Principles of Logic, by Professor Schuyler, of Baldwin university is a good example of that useful sort of text-book which offers a minimum of text and a maximum of class-room work. As an outline it is well conceived and well drawn. To the teacher who is thoroughly conversant with the subject it affords a general plan of instruction with abundant opportunity to draw upon his own resources and follow his own method. A noticeable feature of the book is the large use made of formulas and of symbolic notation. Most logicians would probably attach less importance than the author does to the fourth figure in syllogisms, and more to the judgments U and Y; but the plan of the work allows the teacher to adjust the proportions of topics at his discretion.

L'Astronomie, Revue mensuelle d'Astronomie populaire, de Meteorologie et de Physique du globe, par M. CAMILLE FLAMMARION.—Sommaire du N de Fevrier 1884: *Sirius et son systeme*, par M. C. Flammarion (10 figures).—Le cataclysme de Java, l'eruption de Kra-

katoa et les illuminations crepusculaires (2 figures).—Nouvelles de la Science: La comete de Pons (2 figures).—Observations astronomiques et Etudes selenographiques, par M. Gerigny (3 figures).—(Librairie GAUTHIER-VILLARS, quai des Augustins, 55, Paris.)

OBSERVATIONS OF PONS' COMET, MADE AT THE U. S. NAVAL OBSERVATORY AT WASHINGTON, D. C. BY W. T. SAMPSON AND EDGAR FRISBY.

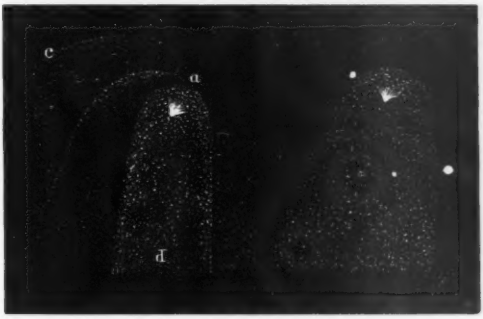
[Communicated by Rear-Admiral Shufeldt, Superintendent.]

1884.	Wash. M. T.	Comet—Star		No. of Comp.	Comet	log (p×Δ)	Comet	log (p×Δ)	Obs'r	Comp. Star
		Δα	Δδ		α app.		δ app.			
	h m s	m s	′ ″		h m s		° ′ ″			
Jan. 2	5 46 50.0	+2 31.64	+5 45.0	20.4	21 53 30.44	9.503	+20 47 14.0	0.519	S	1
2	6 0 5.3	−1 24.42	−0 56.4	20.4	21 53 34.48	9.531	+20 46 20.0	0.531	S	2
3	5 39 53.3	−4 11.65	+4 37.6	20.4	22 0 35.66	9.475	+19 7 49.4	0.536	S	3
3	7 14 8.9	−0 53.65	+6 25.3	20.4	22 1 2.87	9.630	+19 1 4.6	0.618	S	4
5	5 39 40.5	+1 24.73	−1 49.6	20.4	22 14 39.15	9.450	+15 38 57.5	0.582	S	5
6	7 8 55.7	−1 18.78	−0 24.8	20.4	22 21 59.81	9.602	+13 44 2.2	0.653	S	6
7	7 19 46.1	−2 28.32	−5 47.1	20.4	22 28 52.50	9.608	+11 52 57.3	0.671	S	7
9	7 29 7.9	−0 30.58	+0 44.9	25.5	22 42 14.26	9.607	+ 8 7 15.7	0.698	F	8
13	6 20 4.6	−2 38.24	−3 12.8	30.4	23 7 3.89	9.480	+ 0 37 30.3	0.738	S	9
17	7 27 27.8	+3 30.07	−1 0.1	15.3	23 30 8.96	9.585	− 6 47 39.9	0.774	F	10
20	6 2 16.2	+1 11.30	−4 42.7	25.5	23 45 20.31	9.419	−11 49 34.8	0.818	S	11
21	6 0 43.1	−0 58.02	+9 32.1	20.4	23 50 10.27	9.415	−13 27 3.4	0.827	S	12
21	7 10 53.7	+0 35.75	+16 24.8	25.5	23 50 24.10	9.565	−13 31 23.1	0.806	F	13
22	7 21 27.7	+0 41.40	+1 36.8	20.4	23 55 7.18	9.582	−15 6 33.0	0.807	S	14
25	7 4 26.7	−0 30.76	+3 38.6	30.6	0 8 13.98	9.565	−19 30 58.6	0.828	S	15
26	6 3 47.0	+1 20.58	+1 15.4	20.4	0 12 9.76	9.435	−20 50 6.2	0.858	S	16
Feb. 1	6 55 21.0	+1 42.42	+6 7.0	20.4	0 34 4.88	9.580	−28 9 37.7	0.851	F	17

ADOPTED MEAN POSITIONS OF COMPARISON STARS.

Star.	α 1884.0	δ 1884.0	Authority.
	h m s	° ′ ″	
1	21 50 59.10	+20 41 17.6	Weisse (2) 21, 1209
2	21 54 59.18	+20 47 5.0	" (2) 21, 1318
3	22 4 47.54	+19 3 1.1	" (2) 22, 67 and 68
4	22 1 56.77	+18 54 28.6	$\frac{1}{3}$(*Ll.* + *Rum* + *Lam.*)
5	22 13 14.64	+15 40 37.7	Weisse, 22, 233
6	22 23 18.77	+13 44 18.4	" 22, 460
7	22 31 20.97	+11 58 36.5	" 22, 626
8	22 42 44.97	+ 8 6 24.4	" 22, 866
9	23 9 42.18	+ 0 40 39.8	" 23, 145
10	23 26 38.99	− 6 46 40.0	" 23, 502
11	23 44 9.12	−11 44 49.9	" 23, 868
12	23 51 8.40	−13 36 32.5	" 23, 1014
13	23 49 48.47	−13 47 44.9	$\frac{1}{3}$(*Weisse* + *Lamont* + *Stone.*)
14	23 54 25.91	−15 8 6.2	Arg. Oeltz. s. 23179
15	0 8 44.89	−19 34 31.8	Stone 70
*16	0 10 49.34	−20 51 15.9	Ll. 234
17	0 32 22.73	−28 15 36.0	Arg. Oetz. s. 315

January 17, I could see the faint outlines *ad* and *ac* quite distinctly. And frequently before I have suspected them by moving the telescope back and forth; but last night, (21st), I could see nothing of them, probably because the central part was so bright. The head was



PONS-BROOKS' COMET, JAN. 17-21.

a beautiful sight last night. The nucleus was flesh colored, the fan bluish pink and the whole head bluish white. The blue tint is, I suppose, the color of the sky showing through the comet.

I traced the tail with an opera-glass to nearly 20°.

*Baily's reduction of this star is 1′ wrong. Compare also Gould's Uranometria Argentina.

The head was equal to τ *Ceti* in brightness.

The star on the right side of the comet's head Jan. 21st, is Lalande 46929, 9th magnitude, Weisse 23rd, 1014, 9th magnitude.

The other two were much fainter and could scarcely be seen through the matter of the comet. H. C. WILSON.

OBSERVATIONS OF COMET I, 1883, (BROOKS-SWIFT).

[Made at the Cincinnati Observatory.]

1883	Mt. Lookout M T.	$\Delta\alpha$	$\Delta\delta$	Comp	α app.	l.f.p.α	δ app.	l.f.p.δ	Star
	h m s.	m s	′ ″		h m s		° ′ ″		
Feb. 28	8 21 39	−0 9.98	+0 31.8	8.6	23 46 10.44	9.709	+31 41 26.7	0.767	1
28	8 21 39	−0 24.88		8.0					2
28	8 21 39	−1 5.26	−4 6.9	8.4	23 46 10.34	9.709	31 41 26.6	0.767	3
Mch. 2	8 3 58	+0 35.26	−3 48.3	18.6	0 5 21.86	9.725	31 58 2.5	0.729	4
7	7 55 21	−0 4.19	−5 21.3	10.4	0 52 39.49	9.731	31 44 3.7	0.681	5
7	7 55 21	−0 29.92	−7 46.7	10.2	0 52 39.79	9.731	31 44 1.7	0.681	6
7	7 55 21	+2 2.12	−0 49.5	10.8	1 47.59	9.730	31 32 35.6	0.667	7
April 8	7 51 7	−0 25.40	+3 59.8	10.6	3 47 31.00	9.687	19 49 18.0	0.712	8
8	8 54 3	−0 42.22	+4 9.3	10.5	3 47 31.01	9.687	19 49 18.7	0.712	9

Star.	α 1883.0	Red.	δ 1883.0	Red.	Authority.
	h m s	s	° ′ ″	″	
1	23 46 20.33	+0.13	+31 40 49.4	+5.5	Leyden IV Z 112 No. 118 and Z 115 No. 130.
2	23 46 35.21	+0.13	+31 41	+5.5	Anonymous. Est. 10 mag.
3	23 47 15.47	+0.13	31 45 28.0	+5.5	Leyden IV Z 118 No. 159 and Z 123 No. 198
4	0 4 46.33	+0.20	32 1 45.2	+5.6	♯(Weisse 0^h 56−57+Ley'n IV Z 112 " 137)
5	0 52 43.32	+0.36	31 49 26.8	+5.0	♯(Weisse 0^h 1315+Leyden IV Z 132 " 68)
6	0 53 8.34	+0.37	31 51 43.4	+5.0	♯(Weisse 0^h 1326+ " IV Z 136 " 105)
7	0 59 45.08	+0.39	31 33 20.2	+4.8	♯(Lalande 1888−1900+Weisse 0^h 1464 +Leyden IV Z 132 No. 176).
8	3 47 55.63	+0.77	19 45 21.4	−3.2	♯(Weisse 3^h 1013+Yarnall 1708).
9	3 48 12.46	+0.77	19 45 12.6	−3.2	♯(Weisse 3^h 1019+Yarnall 1712).

These observations were made by myself with the 11-inch equatorial and filar micrometer. The corrections for differential refraction have been applied. The following notes were recorded.

February 28. "Comet picked up by sweeping 4-inch telescope. Bright round head, but very faint tail. Strong condensation at the center of the head. Very easy to observe."

March 2. "Head bright; strongly condensed toward the center. Tail scarcely visible, but can be traced to one diameter of field, power 90."

March 7. "Head round, condensed in center. Brightness of the center equal 7 mag. star. Tail very faint." H. C. W.

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CALENDAR FOR 1884.

Winter Term begins Wednesday, January 9th and ends March 20th.
Term Examinations, March 19th and 20th.
Heywood Prize Contest, March 19th.
Spring Term begins Wednesday, April 2d and ends June 19th.
Examinations to enter the Collegiate Department, June 13th and 14th. and September 2d.
Term Examinations, June 17th and 18th.
Anniversary Exercises, June 16th-19th.
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